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09/820,244	03/28/2001	Sivananda K. Kanakasabapathy	UTD-00-17	8112

7590 02/13/2004  
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EXAMINER
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VINH, LAN

ART UNIT	PAPER NUMBER
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1765

DATE MAILED: 02/13/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

09/820,244

Applicant(s)

KANAKASABAPATHY ET AL.

Examiner

Lan Vinh

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 28 March 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-33 is/are pending in the application.
- 4a) Of the above claim(s) 33 is/are withdrawn from consideration.
- 5) ☒ Claim(s) 31-32 is/are allowed.
- 6) ☒ Claim(s) 1-30 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.  
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).  
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 0104.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

## DETAILED ACTION

### *Election/Restrictions*

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:
  - I. Claims 1-32, drawn to a method of plasma processing, classified in class 438, subclass 706.
  - II. Claim 33, drawn to a plasma processing system/apparatus, classified in class 156, subclass 345.

The inventions are distinct, each from the other because of the following reasons:

2. Inventions I and II are related as process and apparatus for its practice. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another materially different apparatus or by hand, or (2) the apparatus as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case the apparatus as claimed can be used to practice another and materially different process such as a chemical vapor deposition (CVD) process.
3. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.
4. Because these inventions are distinct for the reasons given above and the search required for Group I is not required for Group II, restriction for examination purposes as indicated is proper.
5. During a telephone conversation with Edwin Flores on 1/8/2004 a provisional election was made with traverse to prosecute the invention of Group I, claims 1-32.

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Affirmation of this election must be made by applicant in replying to this Office action. Claim 33 withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

***Claim Rejections - 35 USC § 112***

6. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

7. Claims 2, 15 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 2 recites the limitation "said chamber" in claim 1. There is insufficient antecedent basis for this limitation in the claim.

Claim 15 recites the limitation "said chamber" in claim 14. There is insufficient antecedent basis for this limitation in the claim.

***Claim Rejections - 35 USC § 102***

8. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

9. Claims 1, 3 are rejected under 35 U.S.C. 102(e) as being anticipated by Miyake et al (US 6,335,535)

Miyake discloses a method for implanting negative ions to generate plasma. This method comprises the steps of:

generating a large quantity of negative hydrogen ions near the substrate 58, the electrons are quenched (col 10, lines 60-62, col 13, lines 25-29; fig. 2), which reads on generating an electron-free ion-ion plasma in the proximity to at least one substrate supplying bias voltage to the substrate in a pulsing manner so that negative ions are attracted to the wafer after the density of electrons is extremely lowered (col 12, lines 55-66, col 13, lines 1-5), which reads on controlling bias to the substrate at time when the ion-ion plasma is present to induce bombardment of the substrate by ions of desired polarity and energy, with substantially no electron bombardment

Regarding claim 3, fig. 2 of Miyake shows that AC bias source is connected to the substrate holder and controlled by circuit 46.

***Claim Rejections - 35 USC § 103***

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

11. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Miyake et al (US 6,335,535) in view of Okubo et al (US 5,744,011)

Miyake's method has been described above. Unlike the instant claimed invention as per claim 2, Miyake fails to disclose that a chamber contains gas phase having high net electron affinity.

However, Okubo, in a method of sputtering using plasma, discloses that gas in a plasma chamber exhibits affinity for electron (col 1, lines 60-62)

Since Miyake is concerned with a method of producing high density of negative ions in a plasma chamber, one skilled in the art would have found it obvious that Miyake's chamber would have produced high net electron affinity in view of Okubo's teaching because Okubo states that a gas exhibiting affinity for electrons because the stream of plasma flowing into the substrate contains the negative ions and radicals (col 1, lines 62-65)

12. Claims 4, 6-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Miyake et al (US 6,335,535) in view of Nogami (US 6,436,304)

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Miyake discloses a method for implanting negative ions to generate plasma. This method comprises the steps of:

applying power to the substrate, located in a chamber, in a pulsing manner to raise the density of the ion in the chamber (col 10, lines 35-56)

applying bias voltage/ signal to the substrate so that negative ion are implanted in the wafer after turning of the plasma in a pulsing manner so the positive ions are not quenched while the electrons are quenched (col 10, lines 37-65), which reads on applying a bias signal to a substrate to induce ion bombardment of the substrate after one of power pulse and sufficient time for the electron density to drop less than the positive ion density

when a period of time has elapsed, electrons, which are relatively light, are rapidly diffused and therefore quenched (col 10, lines 60-63), which reads on wherein the sufficient time substantially prevents bombardment of the substrate by free electrons when bias voltage is applied to the substrate

Unlike the instant claimed invention as per claim 4, Miyake fails to disclose that the electron density drop to less than 1/200 th of the positive ion density.

However, Nogami, in a plasma processing method, discloses that the electron density depends on source power (see abstract)

Hence, one skilled in the art would have found it obvious to modify Miyake by discovering the optimum value for the electron density because Nogami discloses that this is result variable in the same field of endeavor.

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Regarding claim 6, Miyake discloses pulsing oscillate between a maximum level of power and a non-zero minimum level (fig. 3A)

Regarding claims 7-8, 10-12, Miyake discloses that the bias voltage is related to the pulsing of the power (fig. 3A and 3B), the power source connected to RF source 41

Regarding claim 9, Miyake discloses that positive bias voltage is applied to produce positive and negative ions (col 10, lines 36-51)

Regarding claim 13, fig. 2 of Miyake shows that AC bias source is connected to the substrate holder and controlled by circuit 46.

13. Claims 5, 15, 20, 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Miyake et al (US 6,335,535) in view of Nogami (US 6,436,304) and further in view of Okubo et al (US 5,744,011)

Miyake as modified by Nogami has been described above. Unlike the instant claimed invention as per claims 5, 15, 20, 30, Miyake and Nogami fail to disclose a chamber contains gas phase having high net electron affinity.

However, Okubo, in a method of sputtering using plasma, discloses that gas in a plasma chamber exhibits affinity for electron (col 1, lines 60-62)

Since Miyake is concerned with a method of producing high density of negative ions in a plasma chamber, one skilled in the art would have found it obvious that Miyake and Nogami chamber would have produced high net electron affinity in view of Okubo's teaching because Okubo states that a gas exhibiting affinity for electrons because the



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stream of plasma flowing into the substrate contains the negative ions and radicals (col 1, lines 62-65)

14. Claims 14, 16-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Miyake et al (US 6,335,535) in view of Nogami (US 6,436,304)

Miyake discloses a method for implanting negative ions to generate plasma. This method comprises the steps of:

generating a large quantity of negative hydrogen ions near the substrate 58 (col 13, lines 25-29; fig. 2), which reads on generating a population of negative ions in the proximity to at least one substrate

applying bias voltage/ signal to the substrate so that negative ion are implanted in the wafer after turning of the plasma in a pulsing manner so the negative ions are not quenched while the electrons are quenched (col 10, lines 37-65), which reads on applying a bias signal to a substrate to induce ion bombardment of the substrate only at time for the electron density to drop less than the negative ion density

Since Miyake is silent about applying a negative bias voltage (fig. 3B), Miyake's method reads on preventing of the self-biasing of the substrate.

Unlike the instant claimed invention as per claim 14, Miyake fails to disclose that the electron density drop to less than 1/200 th of the negative ion density.

However, Nogami, in a plasma processing method, discloses that the electron density depends on source power (see abstract)

Hence, one skilled in the art would have found it obvious to modify Miyake by discovering the optimum value for the electron density because Nogami discloses that this is result variable in the same field of endeavor.

Regarding claim 16, Miyake discloses that positive bias voltage is applied to produce positive and negative ions (col 10, lines 36-51)

Regarding claim 17, Miyake discloses that the bias voltage is related to the pulsing of the power (fig. 3A and 3B), the power source connected to RF source 41

Regarding claim 18, fig. 2 of Miyake shows that AC bias source is connected to the substrate holder and controlled by circuit 46.

15. Claims 19, 21-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Miyake et al (US 6,335,535) in view of Nogami (US 6,436,304)

Miyake discloses a method for implanting negative ions to generate plasma. This method comprises the steps of:

applying power pulse to a chamber using an modulation waveform to increase the ion density in the chamber (col 10, lines 37-56)

applying bias voltage in related/is synchronized to the waveform (fig. 3A and 3B)

imposing a time delay to lower the density of the electrons and raise the density of the positive ions (col 12, lines 21-61), fig. 3A and 3B shows that the delayed is imposed between the trailing edges of the pulsing waveform when the bias voltage is applied.

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Unlike the instant claimed invention as per claims 19, 29, Miyake fails to disclose that the electron density drop to less than 0.5% of the positive ion density inside the chamber.

However, Nogami, in a plasma processing method, discloses that the electron density depends on source power (see abstract)

Hence, one skilled in the art would have found it obvious to modify Miyake by discovering the optimum value for the electron density because Nogami discloses that this is result variable in the same field of endeavor.

Regarding claim 21, Miyake discloses pulsing oscillate between a maximum level of power and a non-zero minimum level (fig. 3A)

Regarding claims 22, 23, 25-27, Miyake discloses that the bias voltage is related to the pulsing of the power (fig. 3A and 3B), the power source connected to RF source 41

Regarding claim 24, Miyake discloses that positive bias voltage is applied to produce positive and negative ions (col 10, lines 36-51)

Regarding claim 28, fig. 2 of Miyake shows that AC bias source is connected to the substrate holder and controlled by circuit 46.

### ***Allowable Subject Matter***

16. Claims 31-32 allowed.

The following is an examiner's statement of reasons for allowance:

Regarding claim 31, the cited prior art of record fails to disclose a method for plasma processing comprises the step of generating an electron-free ion-ion plasma in

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proximity to at least first and second substrate. The closest cited prior art of Miyake et al (US 6,335,535) discloses a method for implanting negative ions to generate plasma comprises the step of generating a large quantity of negative hydrogen ions while the electrons are quenched/electron-free ion plasma near the only one substrate 58 (fig. 2)

### **Conclusion**

17. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lan Vinh whose telephone number is 571 272 1471.

The examiner can normally be reached on M-F 8:30-5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 571 272 1465. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703 308-0661.



LV  
January 29, 2004